Forgetting

Psychology 248
Prof. Benjamin

Shape of the forgetting function

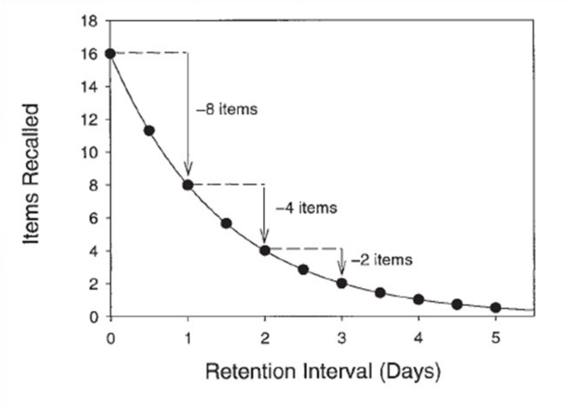


Figure 2. An illustration of the decreasing absolute rate of loss associated with curvilinear forgetting functions.

Exponential forgetting: proportion loss is constant with time

$$R(t) = N_0 e^{kt}$$

N_0 = initial amount of learning
t = time
k = rate of forgetting (here: .50)

Shape of the forgetting function

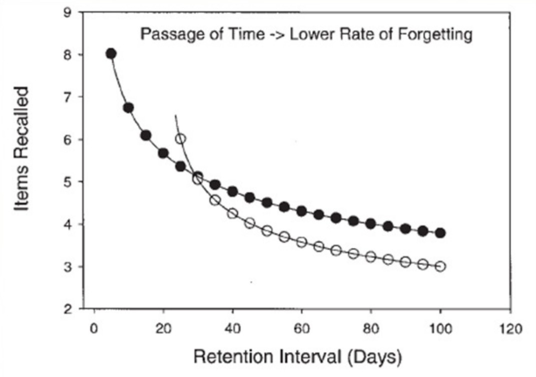


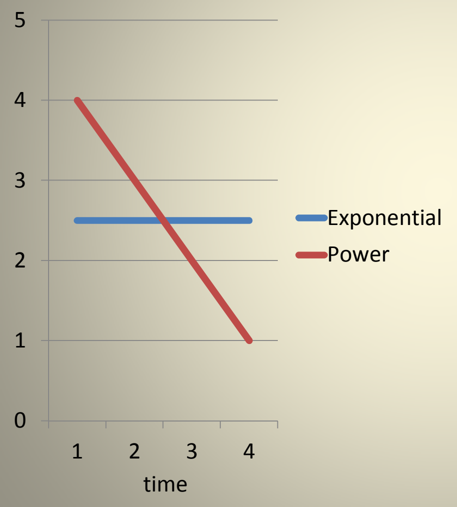
Figure 3. Top: An illustration of Jost's law arising because a higher degree of learning results in a lower rate of forgetting (but the passage of time does not). Bottom: An illustration of Jost's law arising because the passage of time results in a lower rate of forgetting (but a higher degree of learning does not).

Power-law forgetting: proportion loss decreases with time

$$R(t) = N_1 t^{-k}$$

N_1 = learning at time t=1
t = time
k = rate of forgetting

Hazard functions



What is the probability of forgetting if it has survived until now?

Exponential: invariant with time

Power: decreases with time

Actual forgetting functions

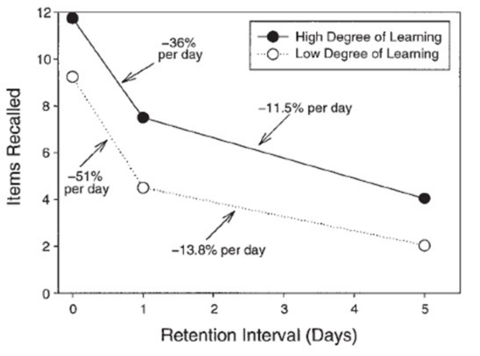


Figure 4. High and low degree of learning data as a function of retention interval. The data illustrate the ever-decreasing proportional rate of loss, as well as the lower proportional rate of loss associated with a higher degree of learning. From "Normal Forgetting of Verbal Lists as a Function of Their Degree of Learning," by N. J. Slamecka and B. McElree, 1983, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* p. 392. Copyright 1983 by the American Psychological Association.

Wixted (2004)

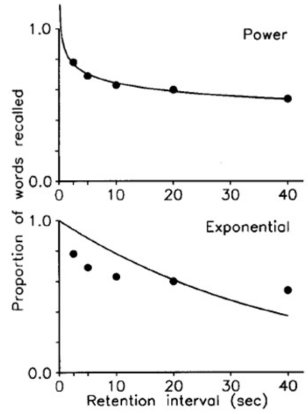


Figure 1. A power function $r(t) = 0.86t^{-0.13}$ and an exponential function $r(t) = e^{-0.025t}$ fitted to the data from the 5-s group in Wixtel and Ebbesen's (1991) Experiment 1.

Wickens (1998)

Jost's Law

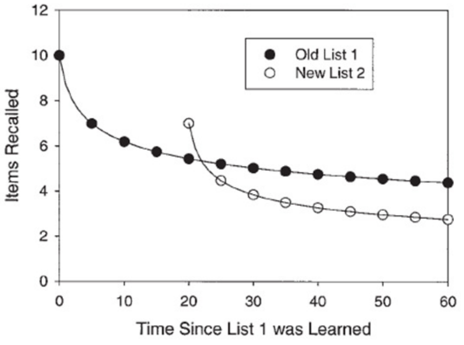


Figure 1. An illustration of Jost's (1897) second law.

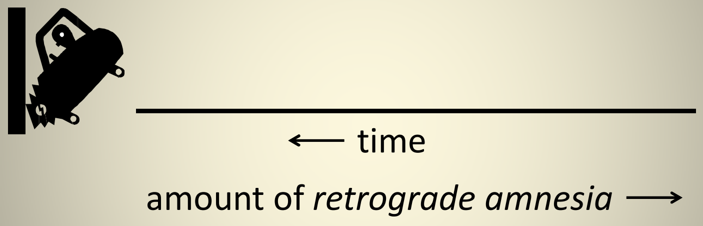
Wixted (2004)

If two associations are of equal strength but of different age, the older one diminishes less with time.

Forgetting becomes less over time because of **consolidation**.

Jost (1897)

Ribot’s (1881) Law



← time

amount of *retrograde amnesia* →

retrograde amnesia is *temporally graded* because of **consolidation**

Rate of forgetting

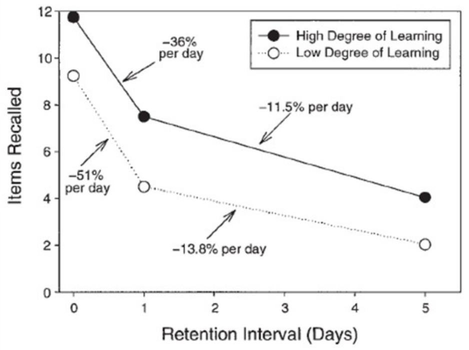
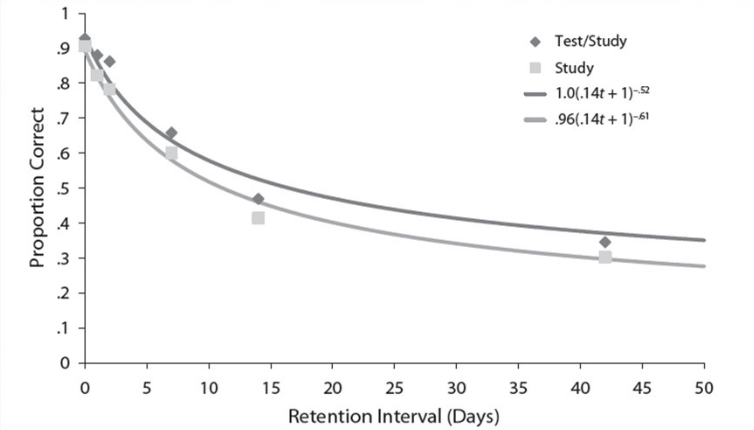


Figure 4. High and low degree of learning data as a function of retention interval. The data illustrate the ever-decreasing proportional rate of loss, as well as the lower proportional rate of loss associated with a higher degree of learning. From “Normal Forgetting of Verbal Lists as a Function of Their Degree of Learning,” by N. J. Slamecka and B. McElree, 1983, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* p. 392. Copyright 1983 by the American Psychological Association.

amount of initial learning does not influence rate of forgetting

Slamecka & McElree (1983), plotted by Wixted (2004)

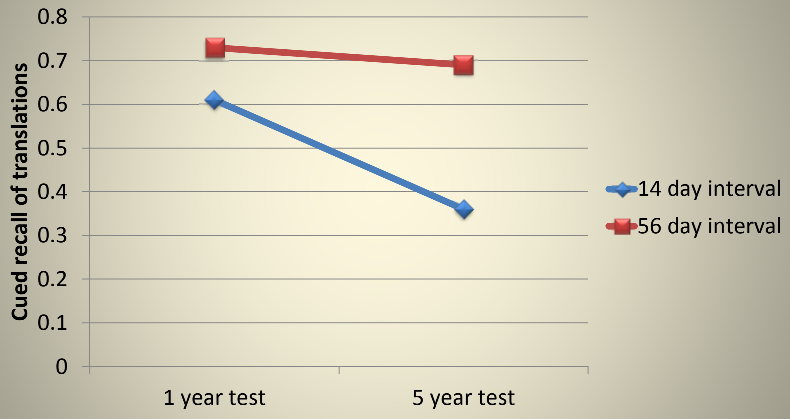
Rate of forgetting



Testing decreases the rate of forgetting

Carpenter, Pashler, Wixted, & Vul (2008)

Rate of forgetting



Spacing during study decreases the rate of forgetting

Bahrick et al. (1993)

Rate of forgetting

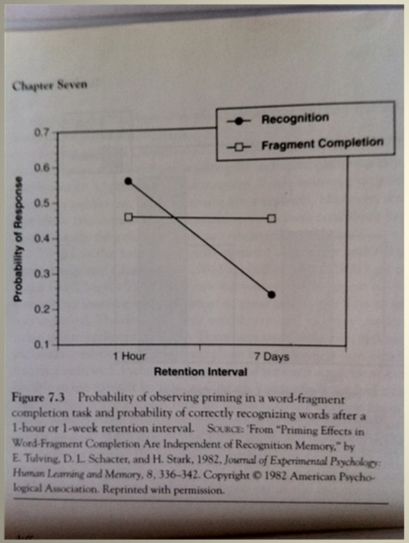
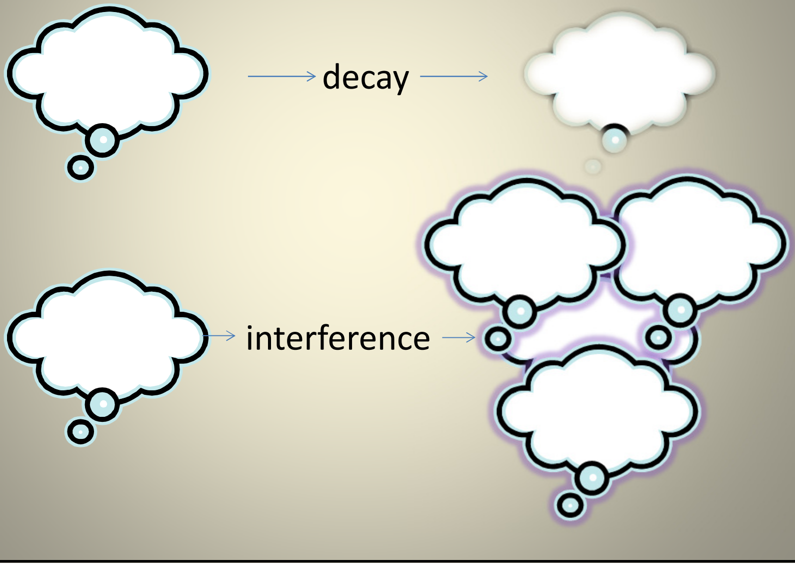

Chapter Seven

Figure 7.3 Probability of observing priming in a word-fragment completion task and probability of correctly recognizing words after a 1-hour or 1-week retention interval. SOURCE: 'From "Priming Effects in Word-Fragment Completion Are Independent of Recognition Memory," by E. Tulving, D. L. Schacter, and H. Stark, 1982, *Journal of Experimental Psychology: Human Learning and Memory*, 8, 336–342. Copyright © 1982 American Psychological Association. Reprinted with permission.

Tests of *implicit memory* reveal slower forgetting

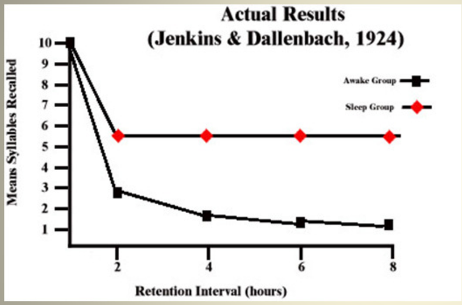
Tulving, Schacter, & Stark (1982)

Decay vs interference

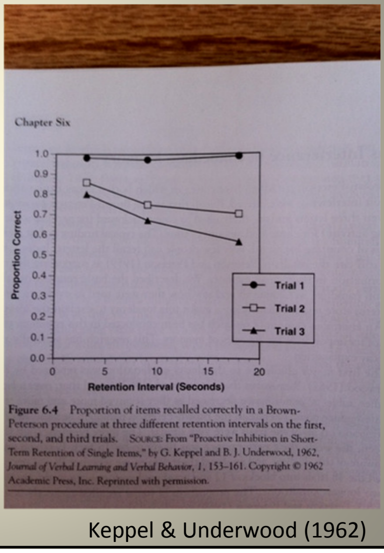

decay

interference

Decay vs interference



Sleep influences forgetting


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Proportion Correct
0
5
10
15
20
Retention Interval (Seconds)
Trial 1
Trial 2
Trial 3

Chapter Six

Figure 6.4 Proportion of items recalled correctly in a Brown-Peterson procedure at three different retention intervals on the first, second, and third trials. SOURCE: From "Proactive Inhibition in Short-Term Retention of Single Items," by G. Keppel and B. J. Underwood, 1962, *Journal of Verbal Learning and Verbal Behavior, 1*, 153–161. Copyright © 1962 Academic Press, Inc. Reprinted with permission.

No difference in retention at 3s and 18s on a first Brown-Peterson trial

Keppel & Underwood (1962)

Learn these animal names

- hyena
- fox
- dingo
- goat
- jaguar
- hare
- marmoset

Recall

Learn these animal names

- coyote
- frog
- parakeet
- cougar
- chinchilla
- buffalo
- baboon

Recall

Learn these animal names

- horse
- kangaroo
- panther
- gorilla
- lynx
- mustang
- mongoose

Recall

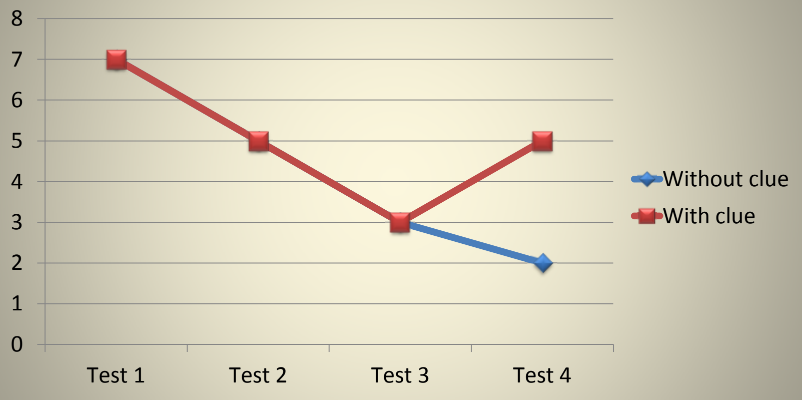
Learn these animal names

- elk
- otter
- antelope
- opossum
- elephant
- anteater
- iguana

Recall

Recall (again, with clue)

Role of retrieval in release from PI



Role of retrieval in release from PI

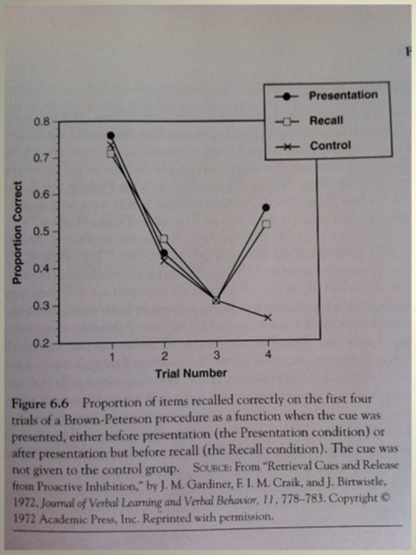

Presentation
Recall
Control
Proportion Correct
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1
2
3
4
Trial Number

Figure 6.6 Proportion of items recalled correctly on the first four trials of a Brown-Peterson procedure as a function when the cue was presented, either before presentation (the Presentation condition) or after presentation but before recall (the Recall condition). The cue was not given to the control group. SOURCE: From "Retrieval Cues and Release from Proactive Inhibition," by J. M. Gardiner, F. I. M. Craik, and J. Birtwistle, 1972, *Journal of Verbal Learning and Verbal Behavior, 11*, 778–783. Copyright © 1972 Academic Press, Inc. Reprinted with permission.

Gardiner, Craik, & Birtwistle (1972)

This result also suggests that the memories do not decay; they simply become inaccessible because of PI (which can be alleviated with the right retrieval cues).

Cue-related interference

- Phase 1: frog – house   pillow – carton
- Phase 2: frog – candle   speaker – bird
  - – **Proactive interference**: Cued recall for *candle* is worse than memory for *bird*.
  - – **Retroactive interference**: Cued recall is worse for *house* than *carton*.

Retrieval-induced forgetting

Study:

- fruit-orange
- fruit-apple
- fruit-strawberry
- fruit-banana
- tool-wrench
- tool-hammer
- tool-screwdriver
- tool-pliers

Retrieval practice phase:

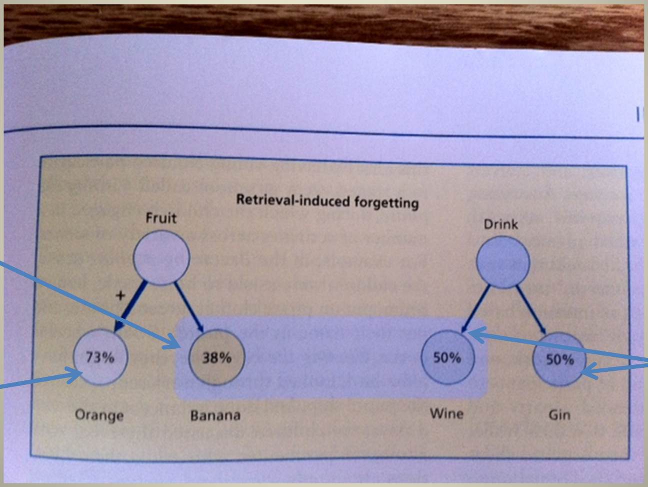
- fruit-orange
- fruit-apple

Test:

- fruit-or___? ← *RP+ item*
- fruit-st___? ← *RP- item*
- tool-wr___?
- tool-pl___?

← *NRP items*

Retrieval-induced forgetting



RP- item

RP+ item

NRP items

Anderson, Bjork, & Bjork (1994)

Retrieval-induced insulation

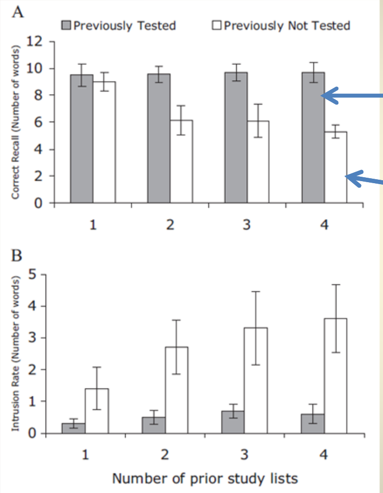


Figure 4. Mean recall performance (correct recall in 4A and intrusion rate in 4B) in Experiment 2 as a function of number of prior study lists and condition. Error bars display standard errors of the mean.

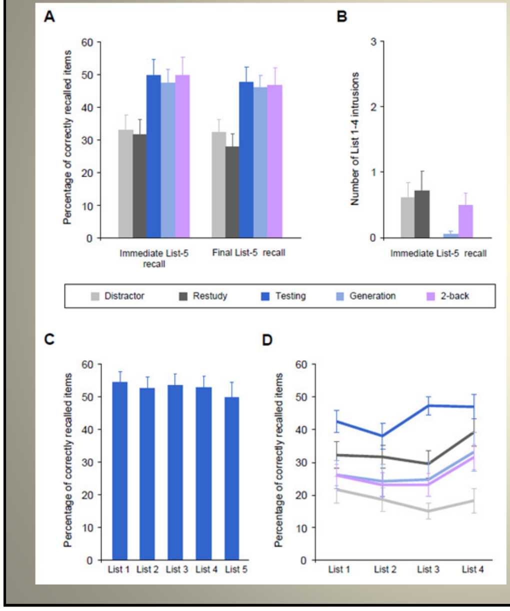
No PI

Buildup of PI

Having been previously tested on a list protects that list from proactive interference

Szpunar, McDermott, & Roediger (2008)

Retrieval-induced insulation



(A) List-5 recall rates as a function of interlist activity in the immediate List-5 recall test and the final recall test.

(B) Number of prior-list intrusions as a function of interlist activity in the immediate List-5 recall test.

(C) Immediate recall rates for each single list in the testing condition.

(D) List 1-4 final recall rates as a function of interlist activity.

Generation*: retrieve something from semantic memory (e.g., sports)*

Pastötter et al. (2011)

Sources of forgetting

- Decay? *probably not*
- Interference? YES
  - – can be protected by consolidation
  - – can be cue-specific
- Retrieval of other materials
  - – retrieval enhances memory for retrieved information
  - – impairs memory for competing information
  - – protects to-be-learned information from interference

Next class:
Intentional forgetting